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**ARTICLE**

# Improvement of Meteorological Services for Food Security in the Drylands of Nigeria

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**Abstract:** Well-coordinated efforts are being made in dishing out meteorological services by the Nigerian Meteorological Agency to ensure the delivery of timely, accurate and quality weather information for the development of agricultural activities in the drylands of Nigeria for sustainable food security. This is through the densification of the observations networks, acquisition of the relevant and latest weather instruments and improvement in weather equipment and training of technical data capturing system, data delivery system, calibration of equipment, installation, routine maintenance of the equipment and training and retraining of staff .This work is aimed at giving an insight to the efforts being made by NIMET towards the issuance of accurate weather information for agricultural development. The information contained in Seasonal Rainfall Prediction (SRP), 2019 and 2020 is given consideration in this study especially as it relates to agriculture for food security in the drylands of Nigeria.

**Keywords:** NIMET; Agriculture; Food security; Drylands

## 1. Introduction

The improvement of meteorological services in Nigeria has been one of gradual process since then, and this is mainly by growing environmental challenges, user requirements and available technical support over the years, as a result of the evolving trend in information and technology (information and communication). For example, the severe drought of 1969 to 1973 raised significant concerns, which led to the meeting of Heads of Government of the West Africa; subsequent call for better understanding of weather and climate of the region and its variabilities [1]. Following this call, coupled with the recognition of meteorology as corner piece for nation building,efforts were doubled to improve on the state of the weather observing network of stations in the country; as well as the transformation of the Department of Meteorological Services into a semi-autonomous Agency with a legal framework and corporate headquarters building.

Rain-fed Agriculture is the widely practiced in Nigeria and is virtually weather dependent. Also, Climate Change which has to do with the weather has influence on agricultural activities and food security. Food security has

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different definitions from various concepts. Food Security has been defined as a condition that allows all people at all times to have physical, social, and economic access to sufficient, safe and nutritious food. The food should also meet the nutritional demands of an active and healthy life of the people [2].

Food security is a major indicator of the wealth and economic sustainability of a nation. Nigeria's economy depends heavily on the agricultural sector though her development funds are derived from petroleum, oil and gas exploitation. The estimates drawn from the 1991 National Population Census in Nigeria show that 69% of the population engages in agricultural activities and 40% of the nation's Gross Domestic Product (GDP) is derived from agricultural activities [3].

The variations in climate and extreme conditions are more experienced on the agricultural activities. These are changes in frequency and intensity of rainfall, droughts, floods, changes in soil moisture and nutrient, increase in pests and diseases of crops and livestock, desertification, land degradation, heat, sea behaviour and erosions. These unfavourable weather events constitute important challenges to crop and livestock production, fish farming and hunting in Nigeria especially the drylands.

## 2. Materials and Methods

The materials used in the study are basically from secondary sources which are from all the operational Directorates in the Nigerian Meteorological Agency which were purposively selected because they are directly related with analysing climate data, issuing of forecast, dissemination of forecasts and predictions and the procurement, installation and maintenance of meteorological instruments.

## 3. Description of the Dryland

### 3.1 Location, Position and Size

The study area constitute an undulating plain with an elevation from about 450 m to 700 m which has latitudes 10° N to 14° N and between longitudes 4° N and 14° N. This zone is between the humid zone to the south and the arid Sahara desert in the north.

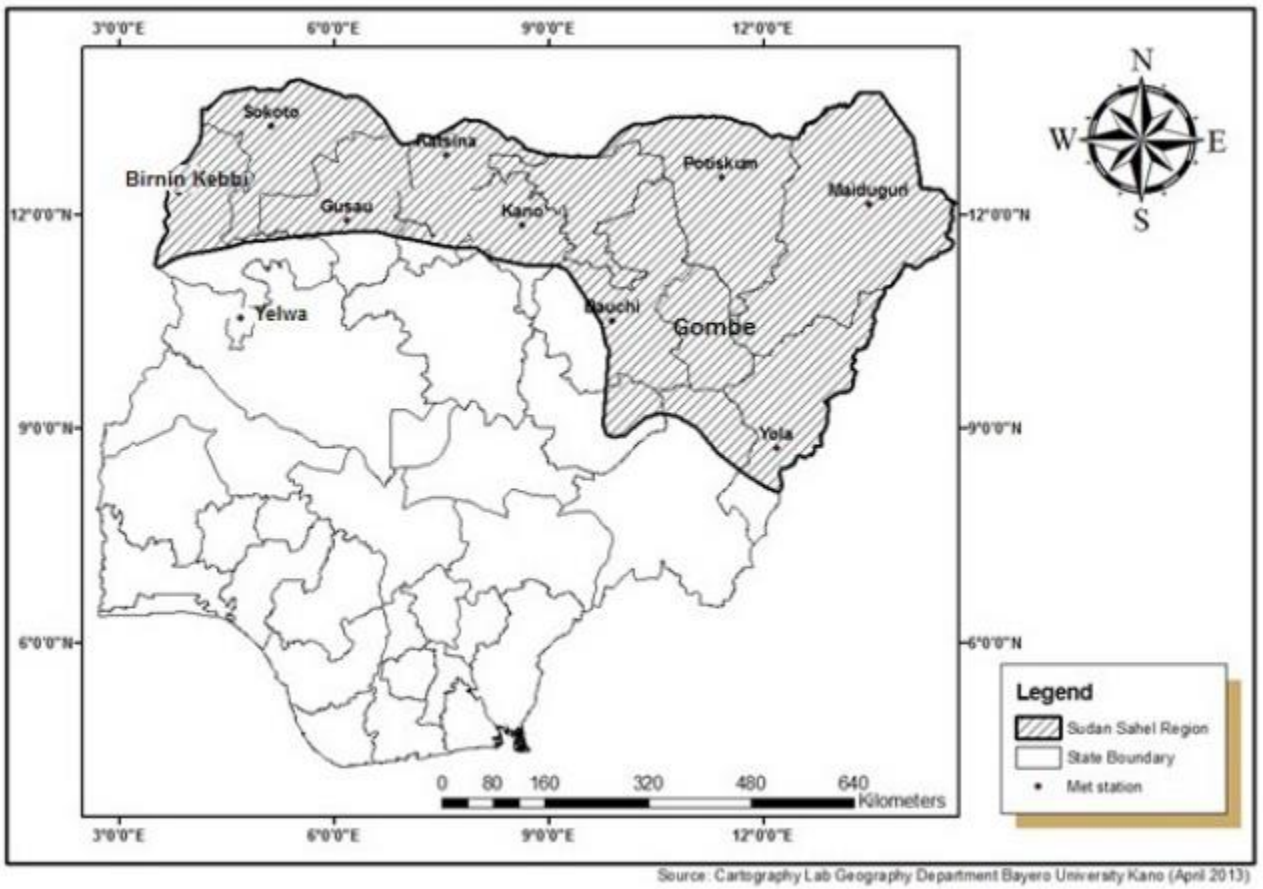


**Figure 1.** Nigeria.

### 3.2 Relief and Drainage

The basement complex and volcanic rocks that rises between 750 metres and 1800 metres above sea level are usually found within the study area [4]. The Rivers that have their sources within the scope of this study River Kaduna, River Ikara among others. The Sokoto plain is located in the North Western part of the study area. It is a flat plain drained by rivers Rima and Zamfara. The Chad plain can also be found here, and it is low and varies between 45 metres and 60 metres below sea level. Rivers in this plain include Komadugu, Yobe and Gana among others.

### 3.3 Climate

Wet Tropical climate in the Sudan zone of the study area and Dry Tropical climate in the Sahelian zone are the dominant. The Sahelian zone is attributed by persistent, intense heat with little variation in temperature. The climate is typically hot all year, and the Sahel rarely experiences cold temperatures. The average high temperatures during the hottest season are typically between 36 ℃ and 42 °C (and even higher in the hottest locations), lasting for more than three months, and the average low temperatures are usually between 25 ℃ and 31 °C. The average high temperature during the "coldest period" is between 27 °C and 33 °C, while the average low temperature is between 15 °C and 21 °C. Because of the tropical climate, the average mean temperature in the Sahel is over 18 ℃ everywhere. Precipitation averages between 500mm in the northeast and 1000mm in the southern subzone, but is unreliable in many areas. Rainfall varies in spatial and temporal dimensions, with interannual variability between 15 percent and 20 percent. The nature of the rainfall supports mostly savanna vegetation with the density of trees and other plants decreasing as one moves northwards. The region is subject to recurring and sometimes intense and persistent periods of dryness.

### 3.4 Soils, Vegetation and Land Use

The zone is covered with highly weathered and distinctly lateral ferruginous tropical soil and a large proportion is also characterized by sandy-fixed undulating topography. The sandy soil is usually low in organic matter, nitrogen and phosphorus and may degrade rapidly under conditions of intensive rainfall [5]. When over-use occurs in this generally sandy environment, denuded patches may appear when the wind-blown sand becomes mobile.

Vegetation is mainly composed of grasslands and savanna, with forests and shrublands. The grass cover is fairly continuous throughout the region and is dominated by annual grass species such as Cenchrus biflorus, Schoenefeldia gracilis and Aristidas tipoides. The acacia species is the predominant tree, with acacia tortilis being the most common along with acacia senegal and acacia laeta. Other tree species include Commiphora africana, Balanites aegyptiaca, Faidherbia albida, and Boscia senegalensis. In the northern part of the Sahel, desert shrub areas, including Panicum turgidum and Aristida sieberana, alternate with grassland and savanna areas.

The landis used for grazing livestock, farming and for shelter and other dwelling purposes. The dry season north, where soil nutrient levels are high, and the vegetated, moist south are more abundant and nutritious as they eat quality feed during the rainy season and are utilized by northern herds and travel south with cattle.

## 4. Results and Discussions

The results of this study are from the information gathered as a result of the discussions with the Directorates of WFS, AMS and DETS. The detailed information is elaborated below:

### 4.1 Meteorological Services in Nigeria

The Meteorological services were established in the country and started its activities in 1937 as the main department responsible for meteorological observation and forecasting. This is all because air transportation of people and goods during the war requires a weather briefing for pilots to successfully fly (Adefolalu, 2006).

The modernization of meteorological services in Nigeria has been one of gradual process since then, driven mainly by growing environmental challenges, user requirements and available technical support over the years, as a result of the evolving trend in technology. For example, the severe drought of 1969 to 1973 raised significant concerns, which led to the meeting of Heads of Government of the West Africa; subsequent call for better understanding of weather and climate of the region and its variabilities (Adefolalu, 2006). Following this call, coupled with the recognition of meteorology as corner piece for nation building, efforts were doubled to improve on the state of the weather observing network of stations in the country; as well as the transformation of the Department of Meteorological Services into a semi-autonomous Agency with a legal framework and corporate headquarters building.

### 4.2 Methods of Data Storage and Dissemination

Data collected through observations at various synoptic stations are first quality controlled by the station's

respective state meteorological inspectors and then sent to the climate return section of Oshodi. The data are then subjected to more extensive quality checks before being transferred to the final repository of the Research Department of Oshodi's National Climatology Archive. This department is responsible for storing the data in manuscript format and providing information on request.

DATAEASE which is used in the CLICOM (climate computing) system acquired by the Department in 1990 is used as the software for data management. The software was created by the World Meteorological Organization (WMO) in 1984 to help the standardization of the climate data storage and exchange amongst member-countries. Data processing and analysis packages like LOTUS and INSTAT are also used at the computer centre. Dissemination of the data/information are in the form of preparation of publications or periodicals.

### 4.3 The Improvement of Meteorological Services in Nigeria

Nigerian Meteorological Agency (NIMET) ispositioned to issue timely, accurate and quality meteorological information for safety and sustainable development in all the sector of the economy. These are the operational structure for effective service delivery:

i. The Headquarters of the Agency is located at the Federal Capital Terotory, Abuja.

ii. The agency has a first class fabrication worshop at Oshodi, Lagos.

iii. It has a World Meteorological Organization Regional Training Centre, Oshodi Lagos

iv. It has Six Zonal offices located at Ibadan, Kaduna, Kano, Maiduguri, Enugu and Port Harcourt.

v. A Central Forecast Office (CFO), at the corporate headquarters, Abuja.

vi. Four major Forecast Offices (Abuja, Ikeja, Kano and Port Harcourt).

vii. Fifty four Observation Stations spread all over Nigeria.

viii. Instrument Calibration Laboratory situated at the headquarters, Abuja.

ix. An Agrometeorological Farm (Oshodi, Lagos).

x. Upper Air Stations at Abuja, Enugu, Lagos, Kano and Maiduguri, Jos, Calabar andYola.

xi. 30 Automatic Weather Stations (Another 37 Received from TAHMO).

xii. 12 Marine Stations, Calabar, Eket, Niomr, Eastmole, Aiyetoro, Warri, Onne, PH Wharf, Apapa, Bonny and Forcados.

xiii. 6 Radar stations at Abuja, Port Harcourt, Yola, Maiduguri, Kano and Lagos.

xiv. 4 Air Quality and Ozone monitoring station at Abuja, Lagos, Enugu and Kano.

### 4.4 The Innovations and Initiatives by the Agency

The Agency has over time become a World class meteorological agency. These are some of the innovations and initiatives achieved:

i. Acquired technology to improve the ability to track dangerous weather systems, provide early warning systems to pilots and the general public, and provide accurate and timely weather forecasts.

ii. The Agency procured and installed 6 Doppler Weather Radars.

iii. EUMETSAT ground receivers for the major forecast offices.

iv. Procurement and the installation of Low Level Windshear Alert System (LLWAS) at Lagos, Kano, Port Harcourt and Calabar and other Airports.

v. Upgrade of the upper air observation system. The Nigerian Meteorological Agency currently operates a network of eight upper air stations nationwide. These are in Abuja, Calabar, Enugu, Jos, Kano, Lagos, Maiduguri and Yola. This system is used to measure meteorological parameters at different altitudes in the atmosphere. It uses a set of sensors, called radiosonde, and this is attached to balloon filled with hydrogen and released into the atmosphere.

vi. Iinstallation lightning and thunder detection system at various stations.

vii. The installation of integrated Automatic Weather Observation Stations (AWOS) in 14 locations. It measures cloud height, cloud base, runway horizontal visibility, wind speed, wind direction, temperature, pressure, precipitation, humidity, radiation and lightning. NIMET is currently providing daily weather forecast services to Liberia and Sierra Leone as part of its technical assistance program.

viii. A data management and information and communication technology (ICT) unit for improving data collection, processing, storage, and applications for product generation in various areas of meteorology. Data management infrastructure. The data management center receives real-time numerical and satellite data for processing, archiving,and distribution to various end users.

ix. Certification of its aeronautical meteorological services using the best practices (ISO 9001: 2015) and makes the agency the first African Country to have achieved this. Also, the Agency is getting the calibration laboratory ready for ISO 17025 certification.

x. Effective understanding with the Dutch consortium TAHMO to establish a robust network of 1000 AWOS in

Nigeria for hydrometeorological monitoring.

xi. Austrian partner UBIMET with the primary purpose of establishing a long-term partnership with NiMet to improve the quality of weather services and products for end customers in Nigeria and NIMET's signed memorandum of understanding. As part of this collaboration, UBIMET is currently installing eight lightning detection systems nationwide to support the monitoring and delivery of Extreme Weather Early Warning Systems (EWS).

xii. Recognizing the need to expand the dissemination of important information on seasonal forecasts for domestic end users, NIMET is working with USAID-funded project MARKETS II as part of a government mission. Organized EA training for trainers nationwide. This is a federal agenda to support agricultural revitalization, maximize production, and achieve food security and strong economic development. SRP step-down workshops were held in 18 states during the growing season of 2017.

xiii. Signed a memorandum of understanding with the West Africa Service Center on Climate Change Adaptive Land Use, increased the density of observatories and developed sophisticated custom weather/climate services in the country.

As part of this cooperation, the parties agree on the following basic principles:

a. Kukua and NIMET will work together to improve weather information across Nigeria.

b. The automatic weather station will be installed at the Telecom Tower site and will be maintained under the responsibility of Kukua and NIMET.

c. NIMET will be the designated provider of ISO standard certification related to instrument accuracy and data.

Despite Nigeria's vast land and efforts to expand observatories nationwide, the number of these observatories is significantly inadequate to address climate change and climate change challenges. Faced with these challenges, NIMET is working with 34 universities to set up and maintain standard meteorological stations nationwide. Data jointly generated and shared for domestic research and development. The agency understands with other partners such as:

i. International Institute of Tropical Agriculture on Climate Smart Agricultural Practices.

ii. International Fund for Agriculture Development on Climate Smart Agriculture and Farmers Associations Across The Country.

iii. Federal Ministry of Agriculture.

iv. Institute of Agricultural Research, ABU, Zaria, Agricultural Insurance Organizations and Companies and Other Community Based Organizations/Non-Governmental Organizations interested in Weather/Climate Services.

### 4.5 Socio Economic Implications of Seasonal Rainfall Prediction (SRP) 2019 on Agriculture

The implications are discussed under the following:

#### 4.5.1 Crop Development

Farmers in the northern states, especially the Sahel, are advised not to plant early, as 2019 is expected to be the year of El Nino. This is because the onset is likely to be delayed in most parts of the country, but this delay is more pronounced in the northern states due to the increased number of El Nino telelinks during the Sahel rainy season (July/September). There is a possibility of becoming. This is the time when the rainy season is drier than usual. Similarly, early termination can occur in the northern part of the country. Shorter growth period. Therefore, due to the potential for water stress, early-maturing and drought-resistantvarieties are encouraged and should be supplemented with irrigation to promote plant growth in areas with less than normal rainfall. TClimate Smart Agriculture should encourage the use of crop trees (gum arabic, date palms, scissors, jatrofa, etc.) for fences, especially in the country's Sudanosahel region, but zero tail, mulching, and other moisture management techniques. Is highly recommended.

#### 4.5.2 Livestock

Forecasts of warmer temperatures in February and April are expected to affect livestock production, especially in some parts of the country, especially in northern states where rainfall has not yet arrived. Decrease or increase in feed production in drylands Vector-borne illnesses, infestation epidemics, and mortality are expected to increase during these months due to temperature fluctuations. Shell quality and layered egg weight can also be affected. Similarly, below-average daytime temperatures in March are expected to affect 1-day-old chicks and increase feed conversion ratios for layers and broilers. Fever-related illnesses can be the result of warmer conditions expected in most parts of the country. Therefore, it is necessary to provide the animals with the necessary vaccines. Especially in the north,fish production can be adversely affected as a result of above-average warm conditions. Aquaculture companies or aquaculture companies should be aware of areas where high emissions are expected to avoid related impacts.

The expected onset of the 2020 growth period is expected to be near or earlier than normal in most parts of the country due to the ENSO neutral signal in the Nino

3.4 region. The map shows that the earliest onset on the south-south coast is likely to occur on February 24, 2020. The start date is expected to change as the ITD gradually resumes its northward vibration, with the states of Sokoto, Kebbi, Zamfara, Katsina,Jigawa, Yobe and Borno and the surrounding areas June 2, 2020 as their onset.

The earliest rainfall cessation date is expected to be the 26th, 2020 around the northern part of Katsina and Sokoto, and the latest cessation date of December 28, 2020 is expected in the Niger Delta region. In general, cessations dates are expected to last from October to November 5 in other parts of the north and until November 15 in Gombe, Joss and Kaduna. In the Central and Southern Inland, cessation dates are expected for November, while in the Southeast, Lagos and Niger Delta, recruitment dates are expected for December.

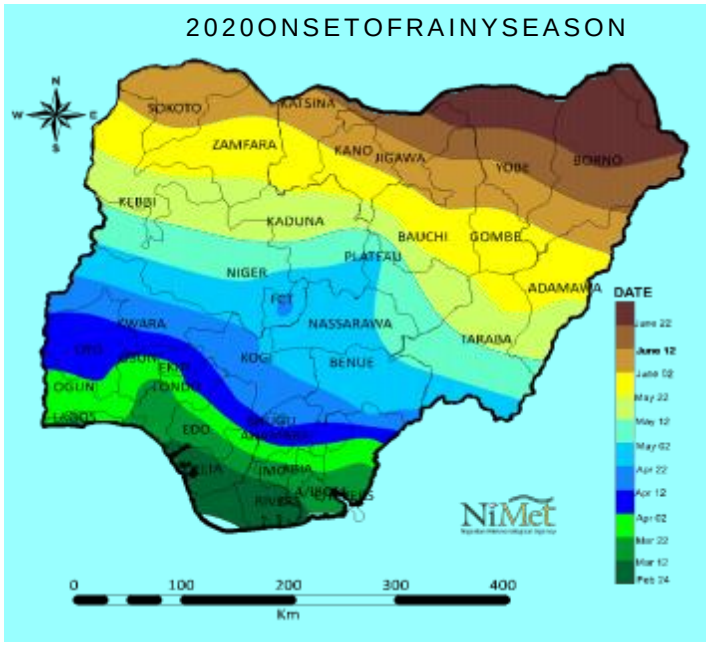


**Figure 2.** 2020 onset of rainy season.

Source: NIMET

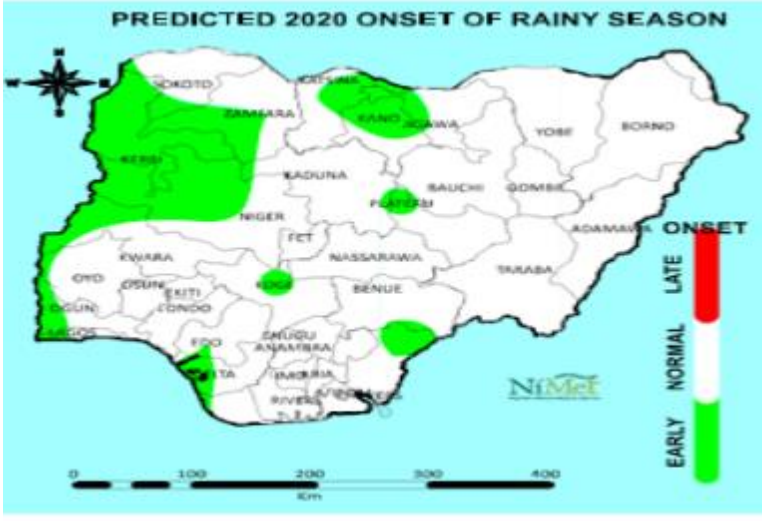


**Figure 3.** Predicted 2020 onset of rainy season.

Source: NIMET

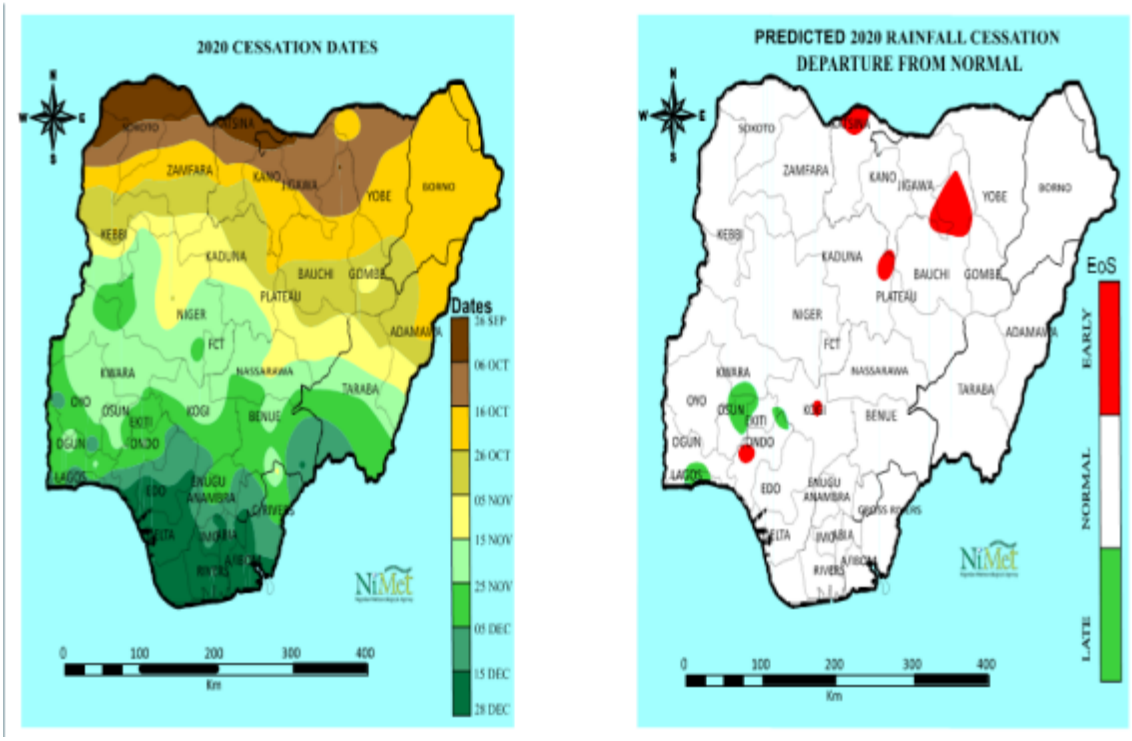


**Figure 4.** 2020 cessation and departure dates.

Source: NIMET

## 5. Conclusions

Nigerian Meteorological Agency has complied with best practices by certifying its aeronautical meteorological services: ISO 9001:2015 certified and the fabrication and calibration laboratory in readiness for ISO 17025 certification is being modified. This seasonal rainfall predictions issued annually by NIMET have gone a long way in providing information for the planning of agricultural activities which targets food security especially in the drylands of Nigeria. All agriculture related activities are dependent to climate and weather conditions. An agricultural decision maker can either be at the mercy of these natural factors or try to benefit from them. The only way to profit from natural factors is to take them into account and learn to know them as well as possible. Agricultural meteorological information, in fact primarily climatological data, is essential for planning agricultural production. Crop production practices such as all land use and management activities, crop selection, livestock and irrigation, pest and disease control, and crop-weather relationships depend on climatic parameters.

## Conflict of Interest

There is no conflict of interest.

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